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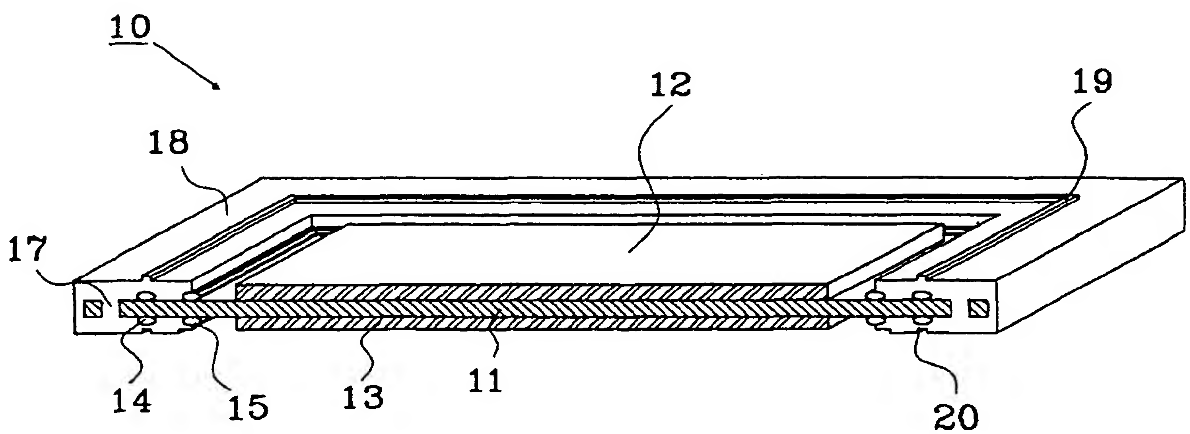
(54) Title: A BIPOLAR BATTERY, A METHOD FOR MANUFACTURING A BIPOLAR BATTERY AND A BIPLATE ASSEMBLY



(57) Abstract: The present invention relates to a bipolar battery 60 having at least two battery cells comprising: a sealed housing, a negative end terminal 62, a positive end terminal 61, at least one biplate assembly 10, 30, 40 arranged in a sandwich structure between said negative 62 and positive 61 end terminals, and a separator 50, including an electrolyte, arranged between each negative 13 and positive 12 electrode forming a battery cell. The biplate assembly is provided with an inner barrier 14; 22 of a hydrophobic material around the negative 13 and the positive 12 electrode, respectively, and an outer seal around the edge 16 of each biplate. Each end terminal 61, 62 is provided with a terminal seal. The edge 16 of each biplate is positioned close to the sealed housing to provide means to conduct heat from each biplate assembly to the ambient environment. The invention also relates to a method for manufacturing a bipolar battery and a biplate assembly.

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A bipolar battery, a method for manufacturing a bipolar battery and a biplate assembly.

Technical field

The present invention relates to a bipolar battery as defined in the preamble of claim 1. The invention also relates to a method for manufacturing a bipolar battery as defined in the preamble of claim 9 and a biplate assembly as defined in the preamble of claim 15.

Background to the invention

In theory, bipolar batteries can be used to improve battery energy storage capacity on a weight and volume basis, to reduce packing weight and volume, to provide stable battery performance and low internal resistance.

A bipolar battery construction comprises an electrically conductive bipolar layer, so called biplate, that serves as electrical interconnection between adjacent cells in the battery as well as a partition between the cells. In order for the bipolar construction to be successfully utilised, the biplate must be sufficiently conductive to transmit current from cell to cell, chemically stable in the cell's environment, capable of making and maintaining good contact to the electrodes and capable of being electrically insulated and sealable around the boundaries of the cell so as to contain electrolyte in the cell.

These requirements are more difficult to achieve in rechargeable batteries due to the charging potential that can accelerate corrosion of the biplate and in alkaline batteries due to the creep nature of electrolyte. Achieving the proper combination of these characteristics has proven very

difficult. For maintenance-free operation it is desirable to operate rechargeable batteries in a sealed configuration. However, sealed bipolar designs typically utilise flat electrodes and stacked-cell constructions that are structurally poor for containment of gases present and generated during cell operation. In a sealed construction, gases generated during charging need to be chemically recombined within the cell for stable operation. The pressure-containment requirement creates additional challenges in the design of a stable bipolar configuration.

Battery manufacturers have not developed bipolar batteries commercially because a working seal design has always been a problem. The vast majority of development work to date has been strictly related to lead/acid technology. The seal is difficult to achieve due to the galvanic creepage of the electrolyte, the corrosive conditions and the heat and pressure generated by the battery. Other manufacturers have tried to make leak-proof seals, and use rigid approaches that ultimately fail due to thermal expansion and pressure changes. In the subject disclosure, the leakage has been separated into two components: electrolyte leakage and gas leakage. A hydrophobic barrier is used in conjunction with a starved electrolyte condition to prevent electrolyte from reaching the pressure seal. The pressure seal is flexible and designed to move with the biplate.

Bipolar batteries have the theoretical advantage to improve battery energy storage efficiency, with reduced weight, volume and cost. The bipolar approach is simple in concept, with both a direct, uniform and short current path, and a minimum number of parts which allow ease of assembly. Despite these potential advantages, there are no bipolar batteries commercially

produced at this time. A review of patent applications reveals many patents on lead acid designs. There are only a few for Nickel based battery systems (e.g. DE 198 381 21 by Deut Automobil GmBH)

New requirements in the field of transportation, communications, medical and power tools are generating specifications that existing batteries cannot meet. These include higher cycle life and the need for rapid and efficient recharges.

NiMH systems are seen as the alternative to meet cycle life, but costs for existing conventional fabrication are too high.

There is a need for a battery that offers high power charge and discharge capability with long life at affordable prices.

Summary of the invention

The object of the present invention is to provide a bipolar battery, preferably a bipolar NiMH battery, that has a better sealability between adjacent cells, to prevent electrolyte leakage paths, in the battery and has better heat conductive properties compared to prior art bipolar batteries.

This object is achieved by a bipolar battery as defined in the characterising portion of claim 1, a method for manufacturing a bipolar battery as defined by the characterising portion of claim 9 and a biplate assembly as defined in the characterising portion of claim 15.

An advantage with the present invention is that the bipolar battery will be a smaller, lighter, and less costly battery that will have improved operating characteristics than prior art bipolar batteries, such as improved power.

Another advantage with the present invention is that the bipolar battery may be used in the automotive market, or other similar high power portable applications, where high power and low weight steer the choice of battery.

Yet another advantage is that the raw material in a NiMH bipolar battery are available, affordable and can be recycled in an environmental manner.

Further objects and advantages of the present invention will be apparent to those skilled in the art from the following detailed description of the disclosed bipolar electrochemical battery and the methods for producing biplate assemblies having pressed electrodes.

Brief description of the drawings

The different embodiments shown in the appended drawings are not to scale or proportion, but exaggerated to point out different important features for the sake of clarity.

Fig. 1 shows a planar view of a first embodiment of a biplate assembly according to the invention.

Fig. 2 shows a cross-sectional view along A-A in figure 1.

Fig. 3 shows a cross-sectional, perspective view of a biplate assembly with a moulded seal according to a first embodiment.

Fig. 4 shows a planar view of a second embodiment of a biplate assembly according to the invention.

Fig.5 shows a cross-sectional view along A-A in figure 4.

Fig. 6 shows a cross-sectional view of a biplate assembly with a moulded seal according to a second embodiment.

Fig. 7 shows a cross-sectional view of a biplate assembly with a moulded seal according to third embodiment.

Fig. 8a-8f illustrates a manufacturing process for a bipolar battery according to the present invention.

Fig. 9 shows a bipolar battery according to the present invention.

Detailed description of preferred embodiments

The major benefits of the bipolar battery design are simplicity and low resistance losses. The parts count of the battery is relative low, consisting only of end plates and biplates, with appropriate assembly and sealing components. Batteries of a desired voltage are constructed by stacking the required number of biplates. The electrical connections between the cells are made as the battery is stacked, since each biplate is electrically conductive and impervious to electrolyte.

With the terminals at each end, the flow of current is perpendicular to the plate, which ensures uniform current and voltage distribution. Since the current path is very short the voltage drop is significantly reduced.

Bipolar batteries will also have significantly reduced weight, volume and manufacturing costs due to elimination of components and the manufacturing approach.

The major problem with bipolar batteries that has not been commercially solved before is obtaining a reliable seal between cells within the bipolar battery. A solution to this problem is presented below.

The seal on a cell is of extreme importance for all types of batteries, and bipolar batteries is no exception. Individual cells contain the active materials (for NiMH batteries it is Nickel Hydroxide positive and metal Hydride Hydrogen storage alloy negative, respectively), separator and electrolyte. The electrolyte is required for ion transport between the electrodes. The best designs, optimised for longevity, weight and volume, require recombination of gasses.

Batteries always produce gasses as they are charged. The gassing rate increases as the battery nears full charge, and reaches maximum when fully charged. The gasses which are produced are oxygen and hydrogen.

Batteries considered for power applications have thin electrodes. Long life with minimum weight and volume are required attributes, which requires a sealed construction.

Oxygen will recombine rather rapidly, so batteries are designed so oxygen will be the first gas generated if the cell is overcharged or overdischarged. This requires two actions:

1) Overbuild the negative active material, generally by 30%, to ensure that the positive electrode, which will gas oxygen, will be the first to gas.

2) Provide for gas passage from the positive to the negative, where the oxygen will recombine. The gas passages are obtained by controlling the amount of electrolyte within the pores of the electrode and through the separator. All surfaces of the electrode must be covered by a thin layer of electrolyte for the transport of ions, but the layer must be thin enough to permit gas diffusion through the layer, and must allow gas passages throughout the active layers and the separator.

The negative electrode would gas hydrogen if overcharged. Because hydrogen does not recombine quickly, pressure would build up within the cell. The oxygen recombination effectively discharges the negative at the same rate it is being charged, thus preventing overcharge of the negative.

The surface area of the active material, combined with the uniform voltage distribution of the bipolar design, enhances rapid recombination

The bipolar approach will ensure that the voltage drop across the active material will be uniform in all areas, so that the entire electrode will come up to full charge at the same time. This will eliminate the major problem in conventional constructions, where parts of an electrode are overcharging and gassing while other (remote) areas of the electrode are not yet fully charged.

The starved electrolyte condition proposed for this battery allows an engineered approach to solve the electrolyte path leakage problem encountered in other design approaches. By adding hydrophobic barriers and controlling surface tension and adjacent surface wetting characteristics , the biplate or starved separator will wick away all electrolyte present at such boundaries, preventing the formation of a conductive electrical path through an electrolyte path across the hydrophobic barrier.

The cells in regular batteries are sealed to contain the electrolyte both for proper performance of the cells, and to prevent electrolyte paths between adjacent cells. The presence of electrolyte paths between cells will allow the electrolyte connected cells to discharge at a rate that is determined by the resistivity of the path (length of path and cross section

of path). The seals on bipolar batteries are more important because the electrolyte path is potentially much shorter. It should be noted that an important feature of this disclosure is the use of a horizontal electrolyte barrier to significantly increase the length of the potential path. An additional concern, is the amount of heat generated by operation of the cell. Depending on the magnitude of heat generated, the design must be able to reject the heat and maintain a safe operating temperature.

If an electrolyte path is developed between cells, a small intercell leakage can be overcome by the periodic full charging of the battery. The battery may be overcharged by a set amount and at a low rate. The low rate would allow fully charged cells to recombine gasses without generating pressure and dissipate the heat from the recombination/overcharge. Cells that have small intercell electrical leakage paths would become balanced.

The flow of heat in a bipolar cell will occur in a radial direction, and in fact end plates are preferably somewhat insulated, to ensure that the end cells operate at the same temperature as the rest of the battery.

The design of the seal must account for the exposure environment of the seal. The seal must be commercially capable of providing the battery performance required by the customer for the intended application. Such a design is presented below.

Figure 1 is a planar view and figure 2 is a cross sectional view (along A-A in figure 1) of a first embodiment of a biplate assembly. Normally a biplate assembly requires a frame

to make up the individual cells within the battery, but for the sake of clarity the frame is omitted in figures 1 and 2.

The biplate assembly comprises a biplate 11, preferably made from Nickel or Nickel plated steel. A positive electrode 12 and a negative electrode 13 are attached to each side, respectively, of the biplate 11. Each electrode is arranged to cover only a central portion of the side of the biplate 11 to leave space for implementing the sealing and heat conducting means. A hydrophobic barrier 14, which prevents formation of an electrolyte path between cells, is provided on both sides of the biplate between the electrode and an elastomer 15. The elastomer 15 prevents gas leakage from the cell together with the frame (not shown). The elastomer is provided between the barrier 14 and the edge 16 on both sides of the biplate 11.

A series of holes 17 through the biplate 11 are also provided around the perimeter between the elastomer 15 and the edge 16. The holes 17 in the biplate 11 are described in more detail in connection with figure 3.

The electrodes 12, 13 may be attached to the biplate 11 in many ways, but preferably the electrodes are manufactured directly onto the biplate by using pressed powder, as is disclosed in the Swedish patent application 0102544-4 with the title "A method for manufacturing a biplate assembly, a biplate assembly and a bipolar battery" by the same applicant. By using the method of pressing powder directly onto the biplate, thin electrodes having less active material may be manufactured.

The shape of the biplate is preferably rectangular to maximise the useful area of the biplate and to better use the biplate for heat conductive purposes. The maximum heat path will be

limited to half the length of the shortest side of the rectangle.

The electrolyte barrier 14 is made from a suitable hydrophobic material, such as a flouropolymer or similar materials. The hydrophobic material may be applied to the biplate as a liquid or solid material and then cured in place, which will bond the barrier to the biplate in an efficient way to prevent electrolyte leakage paths between cells.

Figure 3 shows a perspective view of a complete biplate assembly 10 in cross section, including the frame 18. The frame 18 encompass, in this embodiment, the ring of elastomer 15, and partly encompass the electrolyte barrier 14 on both the negative and positive side of the biplate 11. The frame 18 may have elastic properties allowing it to be compressed when several biplate assemblies 10 are stacked on top of each other to provide good sealing properties of the cells within the battery. Tie rods (not shown) may be applied around the perimeter of the battery to provide the appropriate pressure needed to achieve the sealing of the cells.

On the other hand if the frame 18 is not made from an elastic material, a final sealing material, such as epoxy, must be used to provide the sealing between the endplates and the biplate assemblies.

The frame 18 is provided with guiding means to make it easier to align stacked biplate assemblies 10. These guiding means comprise a tongue 19 arranged on a first side of the frame, e.g. the side corresponding to the positive side, and a corresponding groove 20 on a second side, e.g. the side corresponding to the negative side. The tongue 19 and the groove 20 are positioned directly above the ring of elastomer

15 on each side of the biplate, respectively. The elastomer is preferably more elastic than the material of the frame 18.

In the case when the frame 18 is not elastic, the tongue 19 and the groove 20 will also interact to provide an interim seal to prevent the final assembly sealing material, such as epoxy, from entering the cell when applied.

The elastomer 15 and the frame 18 constitutes together the outer seal of the battery.

The holes 17 through the biplate 11 are filled with the same material making up the frame 18, which preferably is achieved by injection moulding the frame 18, but other techniques may be used. The advantage with providing holes 17 and filling them with moulded material is that the outer seal, i.e. the frame 18 and the encompassed ring of elastomer 15, easily may follow any changes of the size of the biplate. The size of the biplate 11 may change due to heat developed during charging or discharging of the electrodes or the changing ambient temperatures. The elastic properties of the outer seal makes it possible to follow the changes without a breach in the sealing between adjacent cells.

Figure 4 is a planar view and figure 5 is a cross sectional view (along A-A in figure 4) of a second embodiment of a biplate assembly, where the frame is omitted for the sake of clarity.

The biplate assembly comprises a biplate 21, preferably made from Nickel or Nickel plated steel. A positive electrode 12 and a negative electrode 13 are attached to each side, respectively, of the biplate 21. Each electrode is arranged to cover only a central portion of the side of the biplate 21 as described in connection with figure 1 and 2. An electrolyte

barrier 22 is provided on both sides of the biplate between the electrode and an elastomer 23, which is provided between the electrolyte barrier 14 and the edge 16 on both sides of the biplate 21.

In this embodiment no holes are provided around the perimeter of the biplate 21. The ring of elastomer 23 is in this embodiment made wider, thereby achieving an even better seal to prevent gas leakage due to the elastic properties of the elastomer 23, as will come more apparent from the description of figures 6 and 7.

The barrier, preventing electrolyte leakage, is made from a suitable hydrophobic material, such as fluoropolymer or similar materials as described above. In this embodiment the electrolyte barrier 22 is illustrated as a thin film.

Figure 6 shows a cross-sectional view of a part of a second embodiment of a complete biplate assembly 30, including a frame 31. The frame encompass the ring of elastomer 23 and partly encompass the electrolyte barrier 14 on both sides of the biplate 21. The frame 31 also has guiding means 19, 20 as described above, with the exception that tapered surfaces 32 and 33 are provided on each side of the tongue 19. The advantage with this arrangement is to provide additional means to introduce pressure onto the elastomer 23 when several biplates are stacked. The highest pressure will be directed to an area directly above and underneath each ring of elastomer 23.

Figure 7 shows a cross-sectional view of a part of a third embodiment of a complete biplate assembly 40, including a frame 41. The frame encompass only the ring of elastomer 23 on both sides of the biplate 21. The frame 41 also has guiding

means 19, 20 as described above, with tapered surfaces 42 and 43 provided on each side of the tongue 19. The advantage with this arrangement is the same as described in connection with figure 6.

It is essential that the frame encompass the ring of elastomer to prevent gas leakage from one cell to another. The electrolyte barrier, preventing electrolyte leakage, will function the same irrespectively if the frame partly encompass it or not.

Figure 8a-8f illustrates a manufacturing process in cross section for a bipolar battery according to the invention.

A biplate 21 is provided in figure 8a, which has a predetermined size. The size may vary depending on the intended application.

Figure 8b illustrates the appearance after the steps of providing an electrolyte barrier 22 and a ring of elastomer 23. The electrolyte barrier 22 is provided on both sides of the biplate in a closed path around the area where the electrodes are to be positioned. The ring of elastomer 23, i.e. a closed path of an elastic material, is provided on both sides of the biplate 21 between the electrolyte barrier 22 and the edge 16 of the biplate.

In figure 8c a frame 31 has been arranged around the perimeter of the biplate, encompassing the ring of elastomer 23 and partly encompassing the electrolyte barrier 22. In this example the frame 31 is provided with tapered surfaces 32 and 33 around a tongue 19. A groove 20 is also provided as previously described, where the surfaces 34 and 35 around the groove 20 is essentially flat or slightly tapered.

Where epoxy assembly is required, the assembly should be compressed with the tongue and grooves aligned. This compresses the elastomer and seals the cell, and the taper allows space for addition of the epoxy.

A positive electrode 12 is arranged on a first side of the biplate 21 in figure 8d, and a negative electrode 13 is arranged on a second side of the biplate 21 in figure 8e. The electrodes are preferably made from pressed powder as described above. The result of this step is the complete biplate 30 assembly that is the essential part of the bipolar NiMH battery.

Figure 8f illustrates what happens when two biplate assemblies are stacked on top of each other. A first biplate assembly 30b is arranged on top of a second biplate assembly 30a so that the tongue 19a of the second biplate assembly 30a is inserted into the groove 20b of the first biplate assembly 30b. A separator 50 is arranged between the positive electrode 12a of the first biplate assembly 30a and the negative electrode 13b of the second biplate assembly 30b.

Typically the separator 50 comprises about 5% voids for gas passages. The gas passages provide a possibility for the gas created at the positive electrode 12a, during charging, to find a path to the negative electrode 13b where it will recombine.

The separator is squeezed between the electrodes and kept in place by friction when the biplate assemblies 30a, 30b are pressed towards each other. The pressure will deform the frame so that the tapered surfaces 32 and 33 of the first biplate assembly 30a will, at least partially, be in contact with the essentially flat surfaces 34 and 35 around the groove 20. A

force will deform the rings of elastomer 23 being adjacent the deformed surfaces, thereby establishing an effective outer seal. A battery cell is indicated by the reference numeral 51.

A bipolar battery also needs a positive end plate and a negative end plate to complete the battery. This is illustrated in figure 9, which show a complete bipolar battery including three battery cells, cell 1, cell 2 and cell 3.

The battery 60 in figure 9 comprises a positive end terminal 61, two stacked biplate assemblies 30a and 30b (as previously described in figure 8f) and a negative end terminal 62.

The positive 61 and negative 62 end terminal are comprised of an end plate 63 and a positive electrode 12 and a negative electrode 13, respectively. The structure of the end terminals is similar to the biplate assemblies with the exception that only a first side of the biplate carries an electrode, electrolyte barrier 22 and a ring of elastomer 23. A frame 64 is created on each end terminal to allow attachment to the stacked biplate assemblies. Terminal cover 65 is provided on the second side of each end plate.

A sleeve 66 is provided around the battery cells to maintain the parts of the battery in operating position after pressure has been applied to the end plates to seal each cell properly, as indicated by the arrows 67. The sleeve may be used as an alignment guide, which indicate that the tongue 19 and the groove 20 would not be necessary to align the endplates and biplate assemblies.

An alternative to the sleeve is to provide holes around the perimeter of the frames from the positive end plate to the negative endplate. These holes could be used for tie rods to

maintain stacked compression and internal gas pressure on the end plates.

The bipolar Nickel Metal Hydride battery appears to be a perfect battery for niche applications such as Hybrid vehicles, soft hybrid systems, Industrial applications, and numerous other applications that will become apparent for a man skilled in the art. The battery will be smaller, lighter, more efficient and have an increased battery life for its type of applications compared to prior art batteries.

Although the description only handles a NiMH bipolar battery, the claims should not be interpreted in a limited sense, but also include other types of batteries, such as Nickel Cadmium batteries.

Claims

1. A bipolar battery (60) having at least two battery cells comprising:

- a sealed housing,
- a negative end terminal (62) having a negative electrode (13),
- a positive end terminal (61) having a positive electrode (12),
- at least one biplate assembly (10, 30, 40), each having a negative electrode (13) mounted on a negative side of a biplate (11; 21) and a positive electrode (12) mounted on a positive side, being opposite to said negative side, of the biplate (11; 21), arranged in a sandwich structure between said negative (62) and positive (61) end terminals, and
- a separator (50) arranged between each negative (13) and positive (12) electrode forming a battery cell, said separator (50) including an electrolyte,

characterised in that

- said negative (13) and positive (12) electrode are arranged in such a way that each electrode only covers a central portion of the side of the biplate (11; 21),
- an inner barrier (14; 22) of a hydrophobic material, preferably a flouropolymer material, is arranged on the negative and the positive side around the negative (13) and the positive (12) electrode, respectively, near the edge (16) of the biplate (11; 21) to prevent electrolyte leakage to an adjacent cell,
- an at least partially elastic outer seal (15, 18; 23,31; 23, 41)) is arranged around the edge (16) of each biplate (11; 21), and each end terminal (61, 62) is provided with a

terminal seal (23, 64), said outer seal and terminal seal are parts of the sealed housing, said outer seal (15, 18) prevent adjacent biplates/end plates from touching each other, and

- the edge (16) of each biplate (11, 21) is positioned close to the sealed housing to provide means to conduct heat from each biplate assembly (10) to the ambient environment.

2. The bipolar battery according to claim 1, wherein a ring of elastomer (15; 23) provide the elastic properties of the outer seal, said ring of elastomer (15; 23) is mounted to the negative and positive side of each biplate (11; 21) between the edge (16) and the inner seal (14; 22).

3. The bipolar battery according to claim 2, wherein the outer seal further comprises a frame (18; 31; 41) encompassing said ring of elastomer (15; 23) on both the negative and positive side of each biplate (11; 21),

4. The bipolar battery according to claim 3, wherein at least one side of said frame (31; 41) has a tapered surface (32, 33; 42, 43).

5. The bipolar battery according to claim 3 or 4, wherein each biplate (11) is provided with openings (17) around the edge (16), which are filled with material during moulding of the frame (18).

6. The bipolar battery according to any of claims 3-5, wherein said frame (18; 31; 41) is provided with a guiding means (19, 20; 66), to align each biplate assembly (10; 30; 40) with adjacent biplate assemblies and/or end terminals(61, 62).

7. The bipolar battery according to claim 6, wherein said guiding means comprises a tongue (19) arranged on the frame (18; 31; 41) on the positive side of the biplate (11; 21) and the terminal seal (64) on the positive side of the positive end terminal (61), and a corresponding groove (20) on the frame (18; 31; 41) on the negative side of the biplate (11; 21) and the terminal seal (64) on the negative side of the negative end terminal (62).

8. The bipolar battery according to any of claims 3-7, wherein said frame (18; 31) partly encompass the inner barrier (14; 22) on both the negative and positive side of the biplate (11; 21).

9. A method for manufacturing a bipolar battery (60) comprising the steps:

- creating a negative end terminal (62) having a negative electrode (13),
- creating a positive end terminal (61) having a positive electrode (12),
- attaching a negative electrode (13) to a negative side of at least one biplate (11; 21) and attaching a positive electrode (12) to a positive side, being opposite to said negative side, of said biplate (11; 21), thereby forming at least one biplate assembly (10; 30; 40),
- arranging said negative end terminal (62), said positive end terminal (61) and said at least one biplate assembly (10; 30; 40) in a sandwich structure to create a sealed housing, and
- arranging a separator (50), including an electrolyte, between each negative (13) and positive (12) electrode forming a battery cell (51),

characterised in that the negative (13) and positive (12) electrode are attached to the biplate (11; 21) in such a way that each electrode only covers a central portion of the side of the biplate, the method further comprising the steps:

- creating an inner barrier (14; 22), preferably a ring of fluoropolymer, which is arranged on the negative and the positive side around the negative (13) and positive (12) electrode, respectively, near the edge (16) of the biplate (11; 21) to prevent an electrolyte leakage path to an adjacent cell,
- creating an at least partly elastic outer seal (15, 18; 23, 31; 23; 41) around the edge (16) of each biplate (11; 21), and creating a terminal seal (23, 64) to each end terminal (61, 62), said outer seal and terminal seals are parts of the sealed housing, and
- positioning the edge (16) of the biplate (11; 21) close to the sealed housing to provide means to conduct heat from each biplate assembly to the ambient environment.

10. The method according to claim 9, wherein the method further comprises the step of creating a ring of elastomer (15; 23) mounted to each side of the biplate between the edge (16) and the electrolyte barrier (14; 22), said ring of elastomer (15; 23) provide the elastic properties of the outer seal.

11. The method according to claim 10, wherein the method further comprises the steps of moulding a frame (18; 31; 41), that encompass the ring of elastomer (15; 23) on both said negative and positive side of each biplate (11; 21),

12. The method according to claim 11, wherein said moulding step comprises the step of creating at least one side of the frame (31; 41) with a tapered surface (32, 33; 42, 43).

13. The method according to claim 11 or 12, wherein said method further comprises the step of creating openings (17) around the edge (16) of each biplate (11), which are filled with material during moulding of the frame (18).

14. The method according to any of claims 11-13, wherein said method further comprises the step of providing a guiding means (19, 20; 66), to align each biplate assembly (10; 30; 40) with adjacent biplate assemblies and/or end terminals (61; 62).

15. A biplate assembly (10; 30; 40) comprising a biplate (11; 21), a positive electrode (12) arranged to a first side of said biplate (11; 21) and a negative electrode (13) arranged to a second side, opposite to said first side, of said biplate (11; 21), **characterised in** that

- said positive (12) and negative (13) electrode are arranged in such a way that each electrode only covers a central portion of the side of the biplate (11; 21),
- an inner barrier (14; 22) of a hydrophobic material, preferably a flouropolymer material, is arranged on the negative and the positive side around the positive (12) and the negative (13) electrode, respectively, near the edge (16) of the biplate (11; 21) to prevent electrolyte leakage to an adjacent cell,
- an at least partially elastic outer seal (15, 18; 23,31; 23, 41)) is arranged around the edge (16) of each biplate (11; 21), said outer seal is close to the ambient environment, and

- the edge (16) of each biplate (11, 21) is positioned close to the part of the outer seal being close to the ambient environment, to provide means to conduct heat from each biplate assembly (10) to the ambient environment.

16. The biplate assembly according to claim 15, wherein a ring of elastomer (15; 23) provide the elastic properties of the outer seal, said ring of elastomer (15; 23) is mounted to the negative and positive side of each biplate (11; 21) between the edge (16) and the inner barrier (14; 22).

17. The biplate assembly according to claim 16, wherein the outer seal further comprises a frame (18; 31; 41) encompassing said ring of elastomer (15; 23) on both the negative and positive side of each biplate (11; 21),

18. The biplate assembly according to claim 17, wherein at least one side of said frame (31; 41) has a tapered surface (32, 33; 42, 43).

19. The biplate assembly according to claim 17 or 18, wherein each biplate (11) is provided with openings (17) around the edge (16), which are filled with material during moulding of the frame (18).

20. The biplate assembly according to any of claims 17-19, wherein said frame (18; 31; 41) is provided with a guiding means (19, 20; 66), to align each biplate assembly (10; 30; 40) with adjacent biplate assemblies and/or end terminals(61, 62).

21. The biplate assembly according to claim 20, wherein said guiding means comprises a tongue (19) arranged on the frame (18; 31; 41) on the positive side of the biplate (11; 21), and

a corresponding groove (20) arranged on the frame (18; 31; 41) on the negative side of the biplate (11; 21).

22. The biplate assembly according to any of claims 17-21, wherein said frame (18; 31) partly encompass the inner barrier (14; 22) on both the negative and positive side of the biplate (11; 21).

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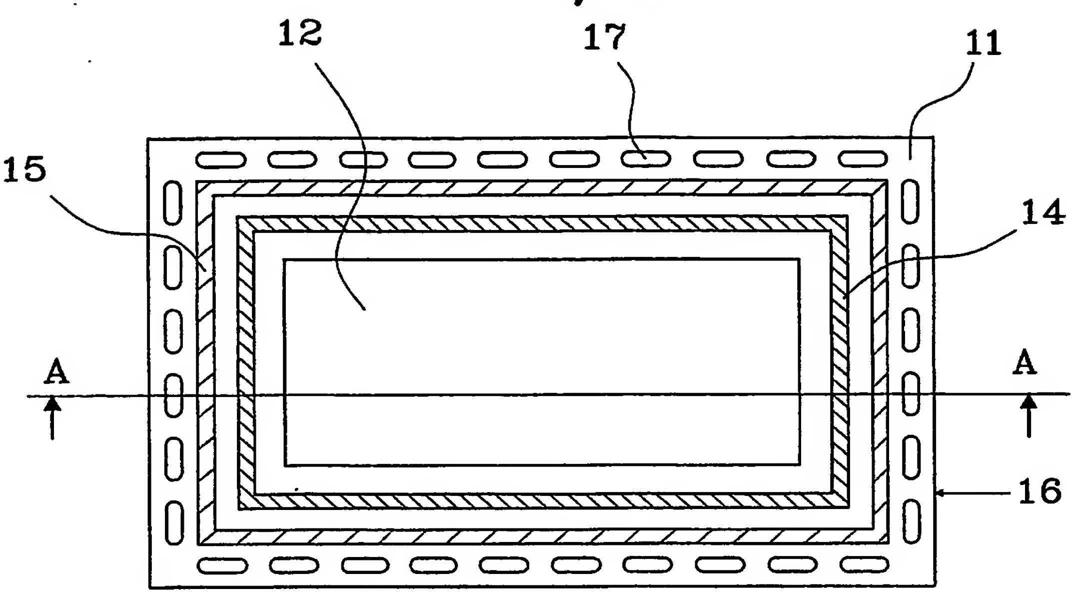

Fig. 1

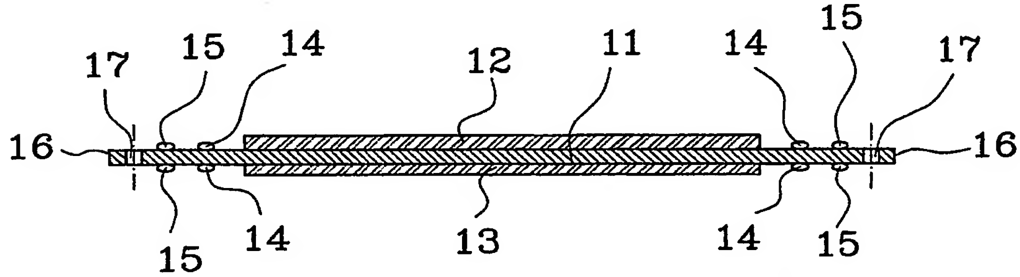

Fig. 2 (A–A)

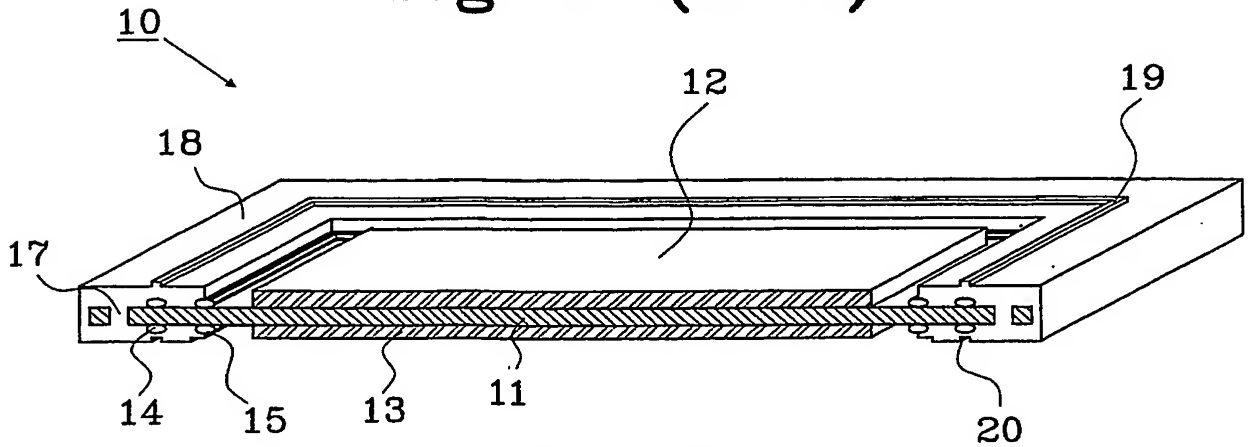

Fig. 3

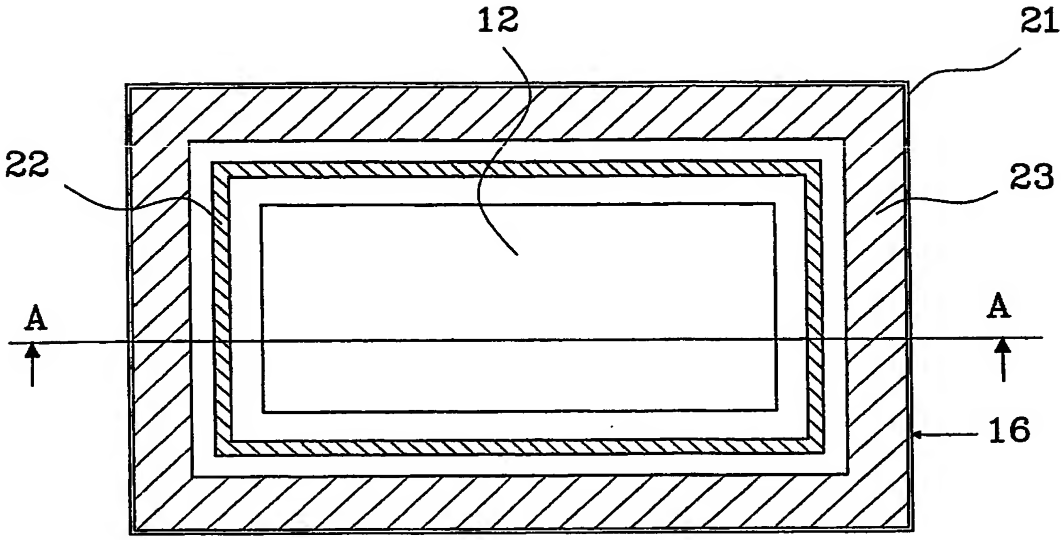

Fig. 4

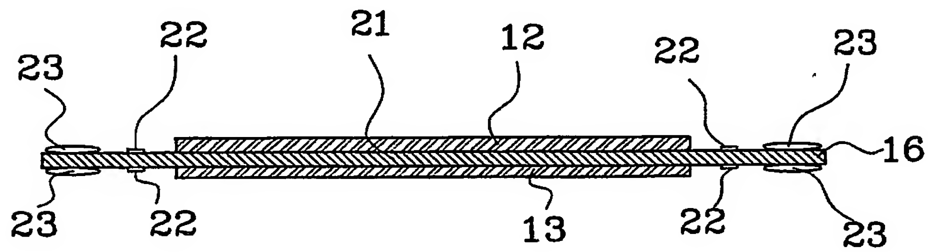

Fig. 5 (A–A)

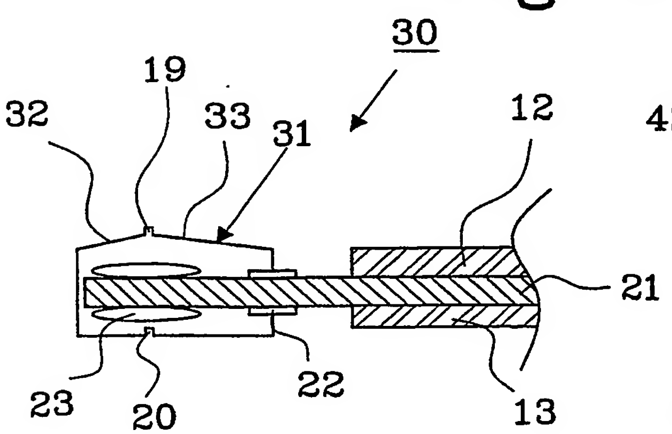

Fig. 6

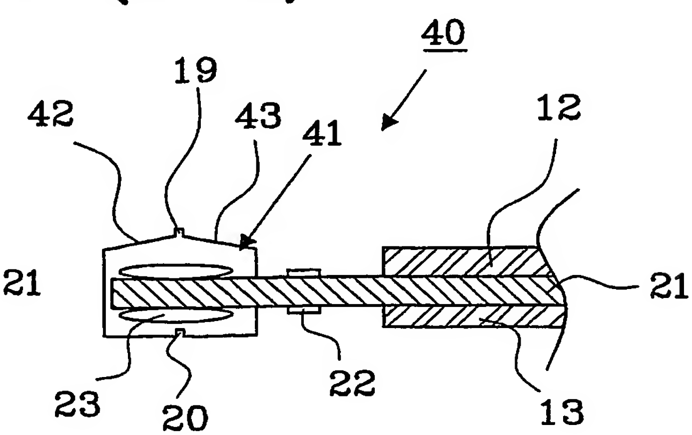

Fig. 7

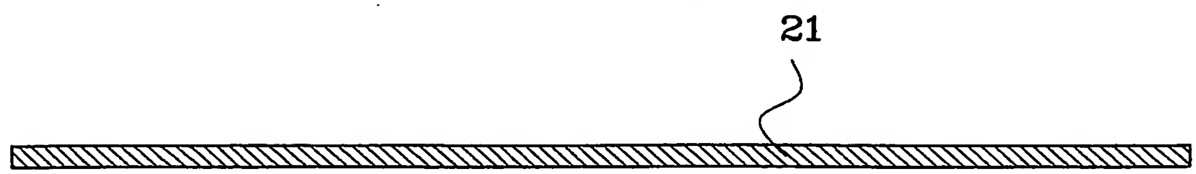

Fig. 8a

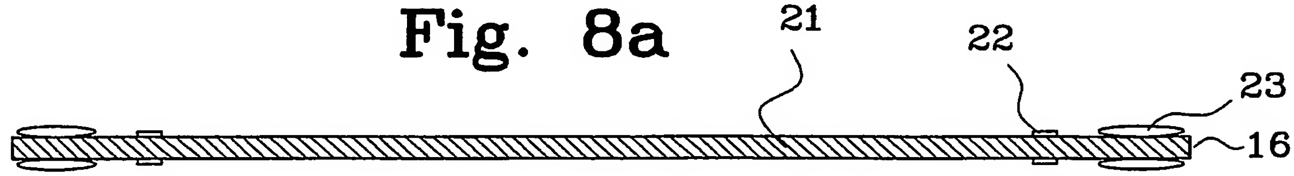

Fig. 8b

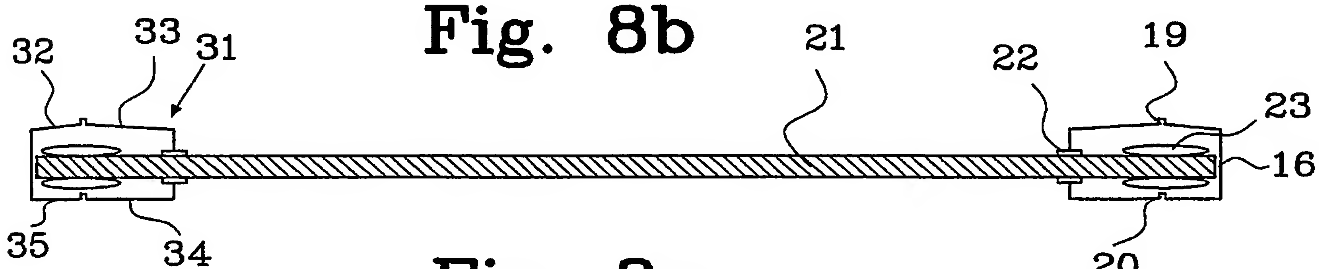

Fig. 8c

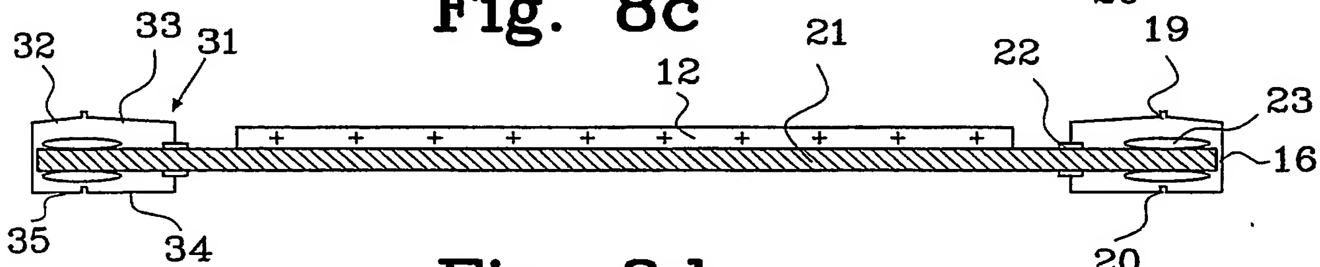

Fig. 8d

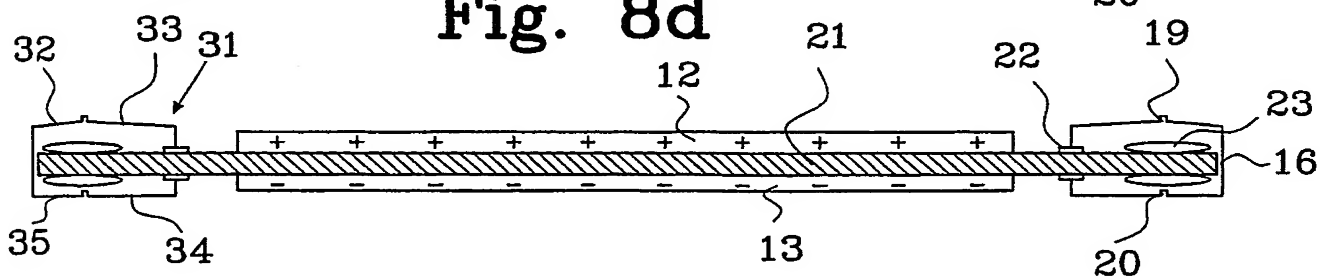

Fig. 8e

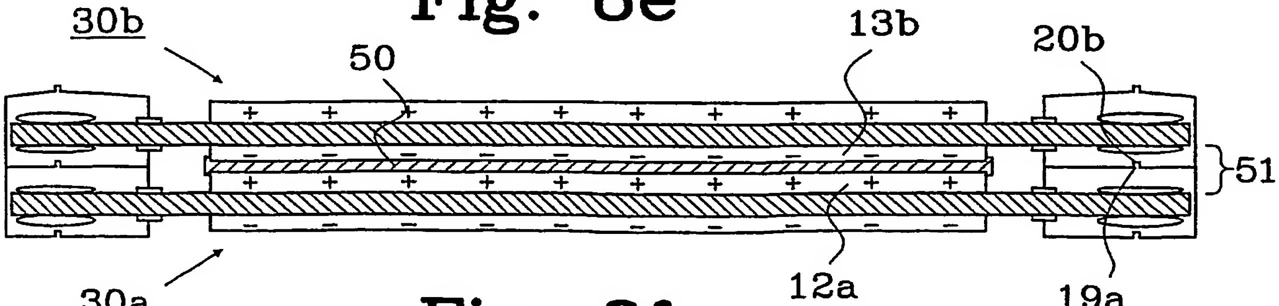

Fig. 8f

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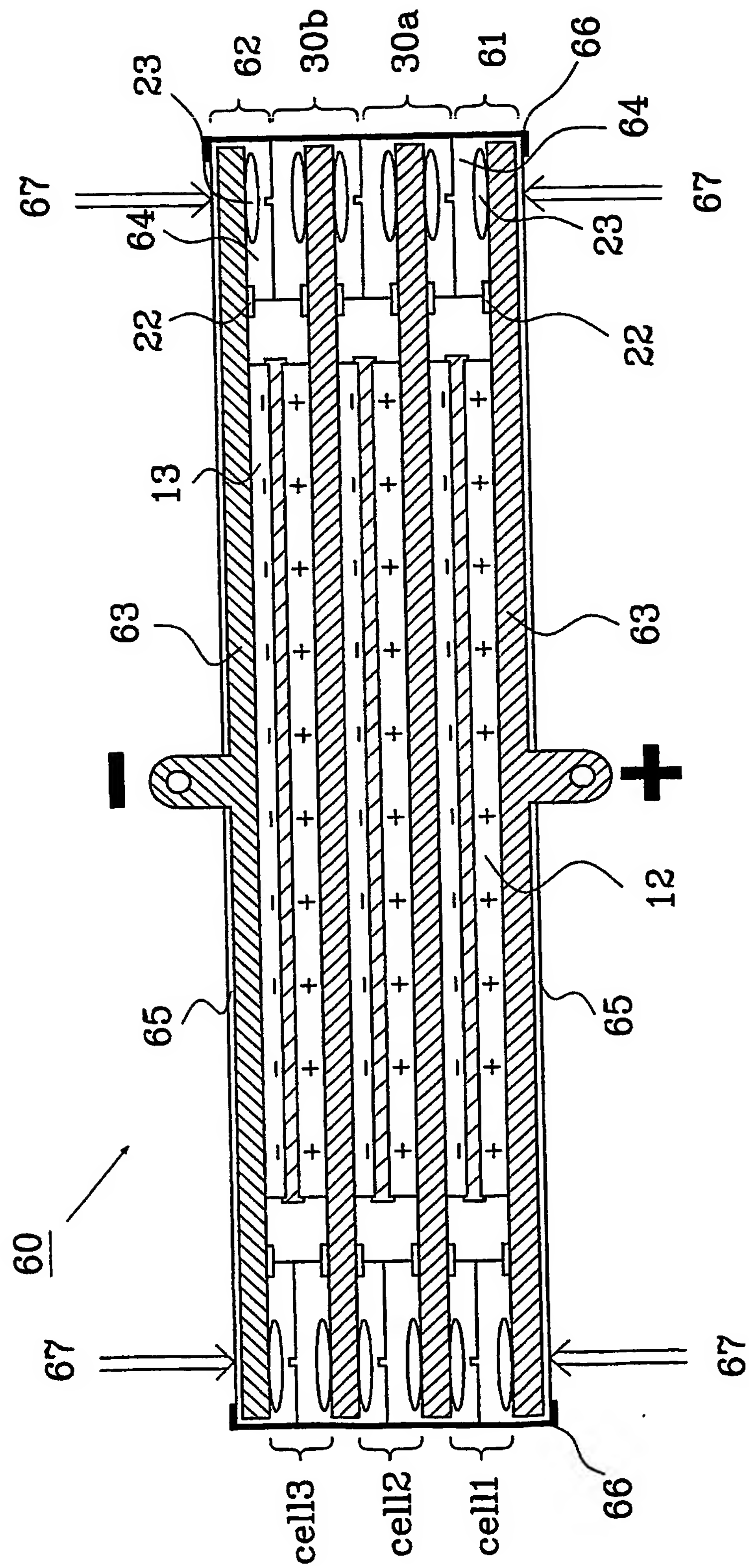
62
30b
30a
61
66
23
64
67
67
64
23
22
22
13
63
63
-
+
12
65
65
60
67
67
cell3
cell2
cell1
66

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/01645

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H01M 10/28, H01M 10/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI DATA, EPO-INTERNAL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	WO 9417563 A1 (BERTIN & CIE), 4 August 1994 (04.08.94), abstract --	1-22
A	EP 0726610 A1 (EDISON TERMOELETTRICA S.P.A.), 14 August 1996 (14.08.96), abstract --	1-22
A	EP 0512417 A1 (ENERGY RESEARCH CORPORATION), 11 November 1992 (11.11.92), abstract --	1-22

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 November 2002	15-11-2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Ulrika Nilsson/MP Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/01645

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	WO 9805081 A1 (BIPOLAR POWER CORPORATION), 5 February 1998 (05.02.98), abstract --	1-22
A	WO 9612313 A1 (BIPOLAR TECHNOLOGIES CORPORATION), 25 April 1996 (25.04.96), abstract -- --------	1-22

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Information on patent family members

28/10/02

International application No.
PCT/SE 02/01645

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